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FISH & WILDLIFE
COMPENSATION
PROGRAM

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Waterfowl and Aquatic Furbearer Inventory and Assessment of Tutu and Mugaha Bay Wetlands, Mackenzie, BC

F. B. Corbould
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The Peace/Williston Fish & Wildlife Compensation Program is a cooperative venture of BC Hydro and the provincial fish and wildlife management agencies, supported by funding from BC Hydro. The Program was established to enhance and protect fish and wildlife resources affected by the construction of the W.A.C. Bennett and Peace Canyon dams on the Peace River, and the subsequent creation of the Williston and Dinosaur Reservoirs.

Peace/Williston Fish and Wildlife Compensation Program, 1011 Fourth Ave. 3rd Floor, Prince George B.C. V2L 3H9

Website: *www.bchydro.bc.ca/environment/initiatives/pwcp/*

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Author(s): Fraser B. Corbould[1]
Address(es): [1] Peace/Williston Fish and Wildlife Compensation Program, 1011 Fourth Ave., 3rd Floor Prince George, B.C. V2L 3H9

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1.0 INTRODUCTION

In 1968 the W.A.C. Bennett Dam was completed on the Peace River near Hudson Hope for the creation of hydro-electric power. Unfortunately, as a consequence of the resulting Williston Reservoir, thousands of hectares of prime wildlife habitat was flooded. In 1988 B.C. Hydro agreed to provide compensation to wildlife and by the summer of 1989 the Williston Wildlife Compensation Program was initiated.

Prior to the formation of the Williston Reservoir, records on waterfowl and furbearers abundance and distribution were limited for the area. Any information that was obtained came from personal contact with people that trapped, hunted or travelled the Finlay, Parsnip or Peace River areas (Bonar, 1975). Even today the Williston watershed is a virtual "black hole" for waterfowl information; based on Campbell *et al*'s (1990) *THE BIRDS OF BRITISH COLUMBIA.* Waterfowl capability for the Williston Reservoir area prior to flooding was classified as lands with moderately severe to severe limitations for waterfowl production (Canada Land Inventory, 1970). This was due to unsuitable water depths, poor marsh edge and low soil fertility. The wide fluctuations that transpired from the reservoir creation further limited these already restricted waterfowl habitats.

Aquatic furbearers had contrasting population responses to the reservoir. The majority of the beaver *(Castor canadensis)* habitat in the watershed was along the larger river systems, and consequently much of this was flooded by the reservoir. This resulted in considerable losses to drowning and starvation (Bonar, 1975). Starvation arose due to their inability to reach food caches during winter drawdown periods. Muskrats *(Ondatra zibethicus)* were not known to have large populations along these major rivers but, instead, resided on small lakes and ponds with emergent vegetation. Today, this is particularly true because the large water fluctuations inherent of the reservoir provides little, if any, opportunity for emergent or aquatic vegetation to establish. Bonar (1975) stated that mink *(Mustela vison)* and river otter *(Lutra canadensis)* populations have increased in numbers since the reservoir was created. It is also thought that many individuals were displaced by the flooding and, therefore, concentrated into the suitable areas remaining.

From the outset, the initial objective of the Compensation Program was to obtain an information base on wildlife distribution, abundance, habitat use, and habitat enhancement potential for the watershed. In order to succeed in this task, wildlife inventories and habitat assessments must be performed. It is the purpose of this report to present an inventory and wetland capability assessment for waterfowl and aquatic furbearers utilizing wetlands adjacent to the Parsnip Reach (Williston Reservoir), near Mackenzie. Information on other wildlife species (eg. large mammals, raptors and shorebirds) frequenting these wetlands were also recorded. As well, a brief review of potential enhancement techniques and their benefits to waterfowl and aquatic furbearers is presented.

2.0 STUDY AREA AND METHODS

The main study area is located approximately 5 km north of Mackenzie incorporating both Tutu and Mugaha Bays and their surrounding wetland areas (Figure 1). Four additional sites were also studied. Sites 1 and 2, located on the Mischinsinlika foreshore and Buth marsh respectively, were part of a wetland creation trial (1990) conducted by the Willistion Wildlife Compensation Program (Figure 2). The third site was the foreshore area across the Parsnip River from Site 1, and the fourth site was the section of Gataiga Creek which intersects Highway 39 (Figure 2).

Colour airphotos (1:10000) are available indicating all locations (see Appendix A). Also, ground photographs (35mm) were taken at most wetland sites. Pre-reservoir waterfowl land capability classifications are listed in Appendix B.

Waterfowl inventories were carried out during the months of May and June with the majority of observations between 7:30 - 10:00 A.M. and 3:00 - 7:00 P.M.. However, due to accessibility and time, portions of Tutu Bay and the Lakes Area were monitored at less favourable periods (10:00 a.m. to 4:00 p.m.). Mid-day hours exhibited decreased feeding by waterfowl and warmer temperatures which resulted in less than optimal viewing. An attempt was made to monitor sites every week for areas frequented regularly by waterfowl and every two weeks for less frequented areas. Binoculars and a spotting scope were utilized at vantage points and during walks of wetland perimeters.

The number of breeding pairs was estimated based on pairs and females remaining on or after May 23rd for early-nesting waterfowl (eg. Canada geese, mallards) and June 12th for late-nesting waterfowl (eg. American wigeon, bufflehead, blue-winged teal). Breeding pairs estimated from groups complied with Ducks Unlimited guidelines (Appendix C).

Vegetation composition, wetland stability and effects of reservoir inundation were noted for all sites. Water quality (pH, alkalinity, hardness) and water depths were recorded for sites with the highest enhancement potential. Water samples were tested on site or on the day of collection, except for the Lakes Area samples which were tested 3 days after their collection date.

Weekly reservoir levels were collected from the Gordon Shrum Sub-station (W.A.C. Bennett dam) and presented in Appendix D, as well as low and high water levels and yearly drawdowns for the past 12 years.

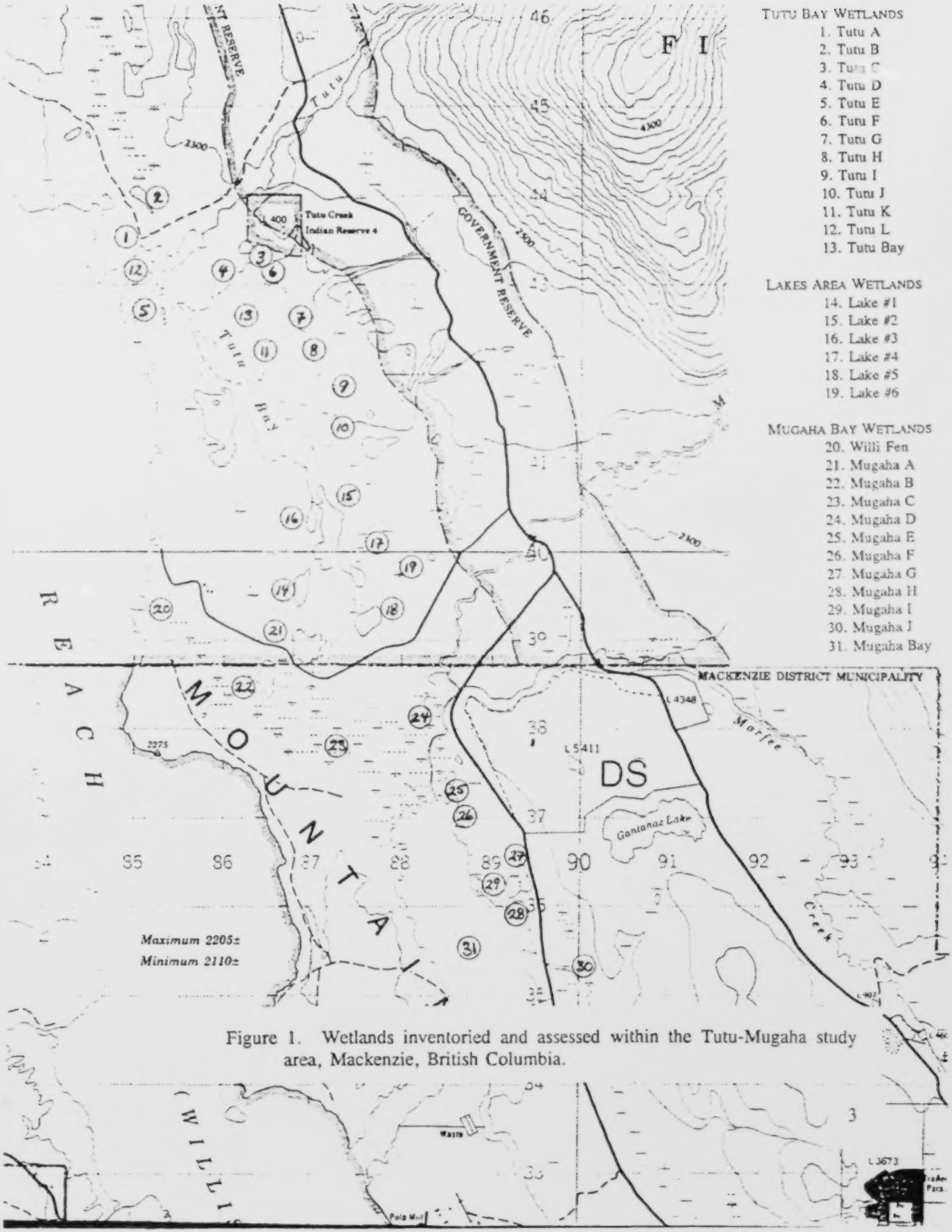

Figure 1. Wetlands inventoried and assessed within the Tutu-Mugaha study area, Mackenzie, British Columbia.

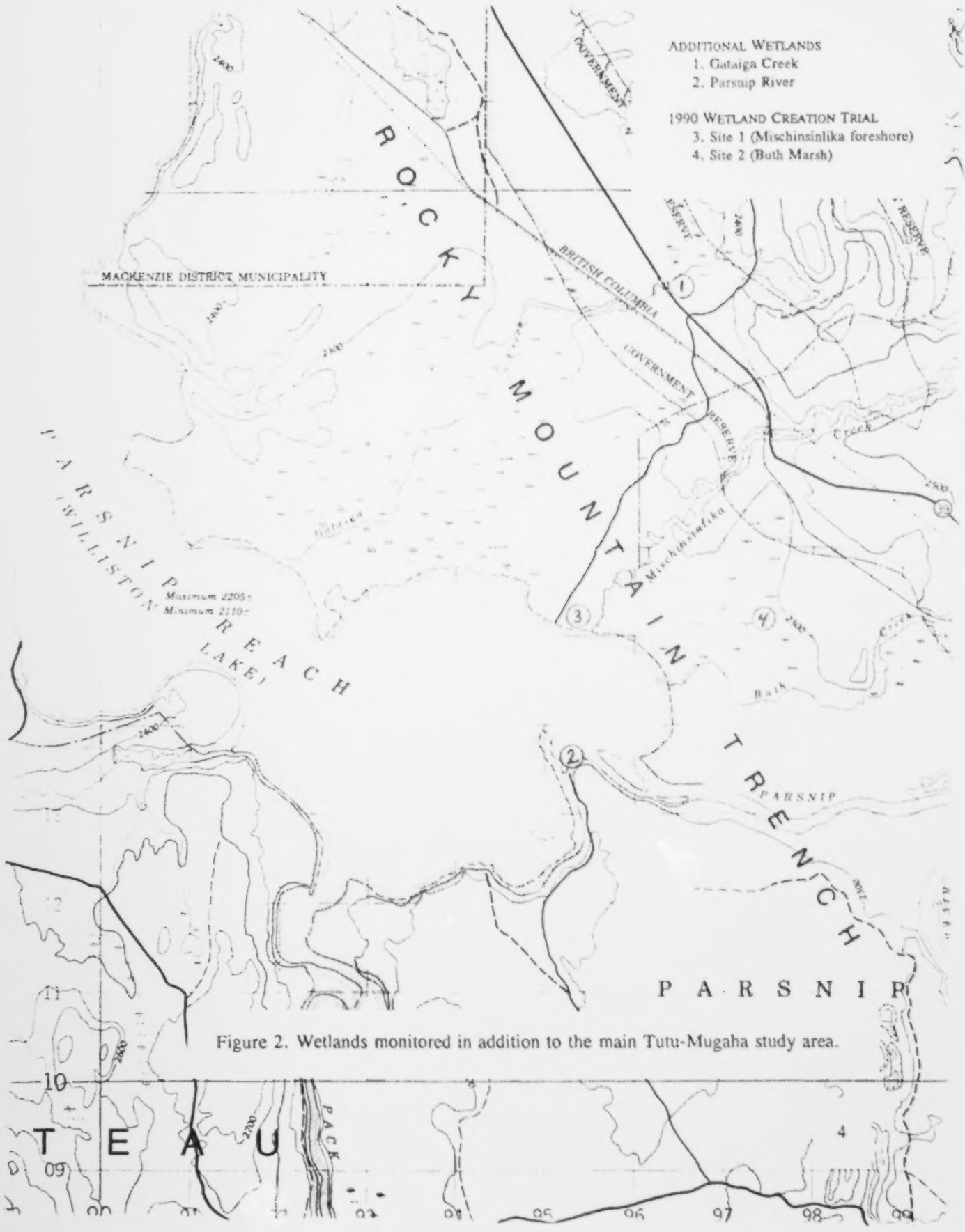

Figure 2. Wetlands monitored in addition to the main Tutu-Mugaha study area.

3.0 ENHANCEMENT TECHNIQUES AND BENEFITS

3.1 Introduction

Numerous techniques are available to develop, restore and maintain waterfowl habitat. The following is a review of some enhancement tools employed and a brief outline of their benefits (Andy and MacNamara, 1948; Schemnitz, 1980; pers, comm., Ducks Unlimited).

If possible, prior to any extensive enhancement development, an application should be made to have the wetland under consideration placed under tighter regulations to limit or control future land uses or conflicts. Three such land transfers used by Ducks Unlimited include Section 12, 13 and 101 of the B.C. Land Act. Also, in order to level ditch, dam or develop by other means within a watercourse, permission under Section 7 of the B.C. Water Act must be obtained.

3.2 Enhancement Techniques

BURNING

Burning as an enhancement tool can accomplish several objectives. Fire can be utilized to remove vegetation otherwise retarding the growth of preferred plant species, or to prepare a site for subsequent seeding programs. Burning can also promote the growth of lush, young vegetation for grazing waterfowl such as Canada geese. Schemnitz (1980) recommends a 3 to 5 year interval for grass rejuvenation.

DAMMING

Damming helps stabilize and ensure suitable long term water levels, and provides an effective means of manipulating plant species composition and abundance by controlling the time and length of inundation or drawdown. Damming also enables managers to alter conditions to best suit the targeted wildlife species. For example, keeping water levels ≤ 1 m in depth during spring and summer provides feeding habitat for dabblers while deeper water levels in late fall and winter provides wintering habitat for muskrats and beaver.

DYNAMITE BLASTING

Dynamite blasting provides a means of creating depressions, deeper open water areas, or channels on a smaller scale than level ditching (see LEVEL DITCHING). Dynamite also lends itself for use in areas inaccessible to heavy machinery.

EARTHEN ISLANDS/PIMPLING

The development of earthen islands, via a backhoe, supplies waterfowl with nesting and/or loafing sites in shallow water areas. Water depths surrounding these earthen mounds consequently increase due to the soil removal, thereby facilitating protection from predators. Muskrats also benefit as the mounds are potential burrowing sites for houses. The maintenance of earthen islands involves the assurance that non-preferred plant species (eg. Canadian thistle) do not pioneer the site and reduce the island's acceptance by waterfowl.

It is also important to ensure that wave action does not erode the island.

FLOATING NESTING ISLANDS

Away from the shoreline, floating islands provide an unobstructed view of the surrounding area and protect the nest from predators. Although geese are the principal species for nesting islands, other waterfowl (eg. mallards, teal) are known to utilize these structures. Islands can also act as protected resting or loafing sites during non-breeding periods.

The types of artificial islands that can be built are numerous and diverse. Nonetheless, two types are presently being utilized by Ducks Unlimited in the northern B.C.: (1) a 7 ft. by 7 ft. wooden platform (DU, 1990), and (2) a 5 ft. by 5 ft. PVC platform (McEneaney, 1988). Island placement is an important factor in producing a successful nesting site (see NESTBOXES). The design of the wooden island encourages the growth of vegetation (eg. grasses) to provide a perpetual source of nesting material. However, the nesting material for the PVC island needs to be replenished every 2 years. It has yet to be determined if floating islands installed at these northern latitudes can withstand ice movements or retain the life span (6 to 10 years) of islands placed in areas of less adverse conditions. Conservative estimates by Ducks Unlimited anticipate the production from floating islands to be 0.5 geese/island or 0.2 ducks/island.

HAY BALES

Round hay bales (1.5 m high by 1.5 m in diameter) wrapped in stucco wire provide secure nesting and loafing sites in shallow wetland areas. The wire wrapping enhances the bale's longevity (up to 5 years) and deters muskrats from burrowing into them. Bale installation can occur during the winter when the wetland is frozen and the bales are more manoeuvrable on the snow. The bales settle into position following spring breakup.

LEVEL DITCHING

Ditches are developed to improve water distribution, provide open water for waterfowl, furnish nesting sites, and encourage aquatic vegetation for waterfowl and furbearers. The creation of these continuous waterways and deeper channels amidst emergent vegetation (eg. sedges and cattails) allow ease of movement and act as brooding corridors and feeding sites for waterfowl. The greater the emergent vegetation is interspersed with open water and feeding areas, the more desirable the wetland becomes for waterfowl. Similar to earthen islands, the material removed and piled along the ditch edge provides nesting and loafing sites for waterfowl as well as potential homes for muskrats. Often level ditching is developed in association with damming. The production of waterfowl from level ditching is dependant upon the suitability of the wetland.

LOAFING LOGS

Loafing logs provide protected offshore loafing and resting sites for waterfowl. Their modest construction involves a single log anchored in open water. And by simply strapping two logs together and adding a small amount of nesting material, one can easily modify a

loafing log into a loon nesting site.

NESTBOXES

Nestboxes provide artificial nesting sites for cavity nesting waterfowl such as buffleheads, goldeneyes, wood duck and mergansers. Once a suitable wetland has been selected, a suitable location for the nestbox placement must also be chosen. Many factors play a part in the selection of a suitable location (eg. orientation to prevailing winds, height above ground, and proximity to water's edge, adjacent loafing sites and other nestboxes). Generally boxes last for roughly 7 to 10 years but all years are not productive ones. Annual, or biannual, maintenance is required to ensure adequate nesting material (eg. sawdust, wood chips) is provided. Nestboxes are usually not utilized until the second or third year after installation, however, goldeneyes have been observed using boxes after one year (Risi, pers, comm.). When used Ducks Unlimited anticipates 3.4 ducks/box.

PLANTING/SEEDING

Planting and seeding allows the introduction or enhancement of plant species preferred by waterfowl, muskrats and beaver for food and cover. The introduction of pondweed and smartweed rootstocks would supply foraging vegetation for divers and dabblers whereas cattail transplants or seeding could furnish over-water nesting sites for some waterfowl (eg. redheads, canvasbacks) and provide a preferred food source for muskrats. And dependant on the waterfowl utilizing the wetland other programs could be developed. For example, an upland area could be seeded with canary grass for upland-nesting ducks, or seeded with a short grass mix for foraging geese. Generally seeding programs involve larger areas (eg. $\geq$10 ha) in order to justify the preparation costs. However, some grass species are fairly inexpensive and require relatively little ground preparation enabling them to be used on smaller areas.

3.3 CONCLUSION

Many of the above enhancement techniques are utilized in combination to reduce or remove the factors limiting waterfowl or aquatic furbearer production. And, although some techniques require heavy machinery or large sums of money (eg. dams), other techniques such as nestboxes, floating islands and loafing logs are inexpensive and have modest maintenance requirements. These latter projects can also be used to heighten public involvement and interest for wildlife in their local area.

4.0 INVENTORY AND ASSESSMENT RESULTS

Inventory results for wetlands frequented regularly by ducks and geese are presented in Table 1. Aquatic furbearer observations and waterfowl observed at less frequented sites are noted under INVENTORY for the individual sites. Estimated breeding pairs and broods observed are recorded in Table 2. A general description for abundance and distribution of wildlife species, other than waterfowl, is summarized (Table 3). Canadian Wildlife Service abbreviations for waterfowl species (eg. CAGO, Canada goose; AMWI, American wigeon) and common names for plant species are utilized [see Appendix E].

4.1 Tutu Bay Wetlands

TUTU A:

INVENTORY: 2 and 3 CAGO were found grazing at the site during the last two weeks of May.

SUE CHARACTERISTICS: a rolling *2.1 ha* grass area with exposed silt which previously was cleared for the Williston Reservoir; limited sign of recent inundation. Low (≤0.5 m) willow also vegetates the site. Two very shallow (<5 cm) surface water areas were noted in early May but by mid-May both had evaporated. Snowmelt appears to be its prime water source. A soil profile indicated a sandy base beneath a 30 cm sand-silt upper layer.

ENHANCEMENT POTENTIAL: none; minimal vegetation present and poor water retention capabilities. Level ditching or blasting would not be feasible as there would be insufficient water from runoff and snowmelt. The coarse textured soils would cause water retention problems and low productivity of vegetation.

TUTU B:

INVENTORY: see Table 1 and 2. Though a pair of CAGO, MALL and HOME each exhibited some nesting characteristics (eg. territoriality, collection of nesting material), most of the waterfowl using the site appeared to be migrants or individuals feeding (possibly nesting elsewhere).

SITE CHARACTERISTICS: a 6.2 ha pond with the east and west shores forested by a mixed stand of trembling aspen, hybrid spruce, lodgepole pine and paper birch. The south end is an open grass-shrub area while the north end is divided into two areas by an outlet creek, negligble flow. A cutblock constitutes the west part while the eastern portion belongs to the upper section of a black spruce bog. No inlet creek exists, therefore, the water source is believed to be from spring runoff and ground seepage. Wood debris and various logs equip the shoreline with ample shoreline loafing sites. Dense sedge emerges in the northeast and southeast corners. Grasses, shrubs and a variety of herbaceous plants vegetate the remaining shoreline areas. Pondweeds, water milfoil and coontail were abundant throughout. Pondweeds were particularly prominent along the eastern shoreline. Emergent and aquatic vegetation facilitate muskrat habitation but the shallow depths (< 2 m) characteristic of the site may pose a problem under winter conditions. Beaver potential is low as a longterm food

Table 1. Waterfowl counts for wetlands frequented within the Tutu-Mugaha study area, May - June, 1991.

LOCATION	DATE	KEY WATERFOWL SPECIES							OTHER WATERFOWL SPECIES
		CAGO	RNDU	AMWI	MALL	BWTE	BUFF	COLO	
Mugaha A	May 8	3		2				2	TRSW(1)
	May 13							2	TRSW(1)
	May 22	2						2	
	May 23				1		2		
	May 30							2	
	June 5	8						2	
	June 12							2	
	June 19							1	
	June 20							2	
	June 27							2	
	June 28							2	
Mugaha B	May 8	8	3	14	4	15	4		NOSH(6), NOPI(5), GWTE(2), CITE(2), EUWI(1)
	May 13	12		6	6	5	4		NOSH(7), NOPI(5), GWTE(4), CITE(1), CANV(1), LESC(1), RNGR(1)
	May 30	2	2	11	3	4	2		GWTE(1)
	June 5	3		9	6	2	3		GWTE(1)
	June 12		5	5	21	3	4		GWTE(2)
	June 19		3	3	6		5		NOPI(2), GWTE(3)
	June 20		8	3	8	2	6		NOSH(6), NOPI(2), GWTE(1)
	June 27			1	3		1		
	June 28			3	2		4		
Mugaha C	May 22	20			3	12			
	May 30				2	3			
	June 5					2	1		
	June 12					2			
	June 20								
	June 28						1		
Mugaha G	May 8	4	2		2				
	May 22				1			1	
	June 4							2	
	June 5	2						2	
	June 12								
	June 19								
	June 27								
Tutu B	May 8	1	11						
	May 15	2	5	5	2	1			
	May 30	6			1				HOME(2)
	June 4				3				HOME(1)
	June 12								
	June 20								
Lake #4	May 23		2		2		5		
	June 5				1		3		
	June 27						1		
Lake #5	May 23	2					1		LESC(5)
	June 5						1		
	June 27		1						

Table 2. Estimated breeding pairs and broods observed for waterfowl within the Tutu-Mugaha study area, May - June, 1991.

LOCATION	ESTIMATED BREEDING PAIRS (BROODS OBSERVED)									COMMENTS
	CAGO	RNDU	AMWI	MALL	BWTE	BUFF	COLO	GWTE	HOME	
Mugaha A	0(2)						1(1)			2 Class Ia COLO. 2 CAGO broods(5 and 6 Class Ib), believed to be successful broods from Mugaha B.
Mugaha B	3(0)	2(1)	2(0)	3(1)	2(0)	3(4)		1(0)		4 BUFF broods(4 and 5 Class Ib, 9 Class Ib, & 2 Class Ic). 3 Class Ia RNDU. 1 Class Ib-c MALL.
Mugaha C					1(0)					No broods, though a pair of BWTE were seen at the site until June 12.
Mugaha G	0(1)			1(0)			1(0)			5 Class Ia CAGO, probably only using area for feeding (possibly a successful brood from Mugaha J). Pair of COLO observed until June 5.
Mugaha J	2(0)									No broods, though 2 eggs were seen in one nest on May 23. Also see Mugaha G comments.
Tutu B	1(0)			1(0)					1(0)	CAGO were seen upto May 30, and MALL until June 4, both appeared to have 1 breeding pair. A drake HOME acted territorial until last seen on June 4.
Tutu C								1(0)		No brood, though a pair of GWTE were seen every two weeks upto June 20; however, flooding of the area had occurred prior to the next observation (July 4).
Tutu Bay							1(0)			No brood, though a pair of COLO were observed regularly near the barren island in the north section of the bay; by the next observation period (July 4) the island was almost totally submerged.
Lake #2	1(1)									On the first visit(May 23) a pair of CAGO and 2 Class Ia were observed feeding on the northern marshy area. They were not observed a second time.
Lake #4				1(0)		1(1)				5 Class Ib BUFF observed on June 27. A nesting MALL was observed on the bog until June 5.
Lake #5	1(0)					1(0)				A territorial drake BUFF was observed on the small pond until June 5. May 23 a pair of CAGO with 2 eggs was observed, however by June 5 there was no evidence of the adults, eggs or nest.
Gataiga Crk		1(1)								1 Class IIa RNDU was observed on June 28.

Table 3. Abundance and distribution of wildlife species, other than waterfowl, visiting wetlands within the Tutu-Mugaha study area, May - June, 1991.

SPECIES	ABUNDANCE	DISTRIBUTION
FURBEARERS		
Beaver	common	Sightings at Mugaha A, G and J and Lake #3; sign throughout.
Muskrat	rare	Single indiv. at Mugaha B; feeding sign at Mugaha C.
River otter	rare	3 indiv. observed at Lake #3.
LARGE MAMMALS		
Black bear	rare	1 male at Mugaha A and tracks seen throughout the lakes area.
Lynx	rare	Single lynx seen at Tutu I & along the road to Mugaha A & B.
Moose	occasional	Tutu B and Mugaha A & B; tracks and pellets throughout area.
RAPTORS		
American kestrel	occasional	Sightings in Tutu Bay; shoreline nest in snag near Tutu I creek.
Bald eagle	common	Nest & eaglet at Tutu G; immatures and adults common throughout.
Osprey	common	Nest at Mugaha A & near Mugaha C and Tutu J.
Northern harrier	rare	Sighting of adult at Mugaha C.
Red-tailed hawk	rare	Sighting of adult at Tutu B twice.
SHOREBIRDS		
Bonaparte's gull	common	Nesting at Mugaha B; upto 3 in Mugaha A & B area and 5 in Tutu Bay.
Common snipe	common	Nest(4 eggs) at Tutu F, common throughout Tutu & Mugaha areas.
Yellowlegs	common	Common throughout study area, especially Mugaha B & C.
Killdeer	occasional	Pairs and indiv. seen at Mugaha B & C and along Tutu Bay shoreline.
PASSERINE BIRDS		
American robin	common	Common throughout all areas of the study area.
Evening grosbeak	rare	Sighting of a group of 8 at Mugaha I.
Marsh wren	common	Very common at Mugaha B, C & G and sightings at Tutu B & Bay.
Red-winged blackbird	common	Very common at Mugaha B & C and sightings thoughout study area.
Song sparrow	common	Common along upper shoreline of Tutu and Mugaha Bays.
Barn swallow	rare	Single sighting of 6 feeding at Tutu C.
Tree swallow	common	Very common throughout study area, using birch snags for nests.
Violet-green swallow	common	Very common throughout study area, using birch snags for nests.
White-crowned sparrow	rare	Infrequent sightings on deciduous vegetation along some shores.
Yellow-headed blackbird	rare	Single sighting of a pair at Mugaha A.
OTHER BIRDS		
Belted kingfisher	occasional	Individuals sighted at Mugaha A & G and Tutu B, C & Bay.
Common crow	occasional	Sighted periodically along Tutu and Mugaha shorelines.
Northern flicker	occasional	Sightings on snags along Tutu Bay shoreline.
Pileated woodpecker	rare	Single sighting at Tutu E on birch snag.
Raven	occasional	See Common crow. Nest at Mugaha G.

source for a colony seems unavailable, yet sporadic disperalists would be expected to benefit from the available vegetation. A water sample tested revealed a pH of 8.2, alkalinity of 102.6 mg/L $CaCO_3$ and hardness at 85.5 mg/L $CaCO_3$.

ENHANCEMENT POTENTIAL: moderate. Since Tutu B is essentially a shallow pond with dense aquatic vegetation the limiting factor appears to be suitable nesting and escape habitat. The sedge areas in the southeast and northeast corners provide some nesting habitat for over-water nesting waterfowl and the forested east and west shores provide possible nesting sites for cavity dwellers or locations for nestbox placement. The introduction of cattails or enhancement of emergent vegetation would provide increased nesting cover for over-water nesting waterfowl and supply expanded escape cover for many waterfowl species. The establishment of 1 or 2 floating islands would provide protected geese nesting sites and the placement of offshore loafing logs would furnish Tutu B waterfowl with protected resting sites. Removing many of the eastern shoreline logs and wood debris may also provide greater upland nesting habitat for dabblers.

TUTU C:

INVENTORY: a GWTE breeding pair was observed until June 20 but within the next 10 days the site was inundated by the reservoir.

SITE CHARACTERISTICS: Tutu C includes a 1.2 ha pond and a 1.2 ha fen. The fen was characterized by a layer of deep (40 cm) organic matter over a soupy leachate. This sparsely grassed fen also had many stumps. Water seepage, not due to the reservoir, was apparent 20 cm below ground level in the middle of the fen (June 20; 665 m). The pond shoreline is virtually barren of vegetation due to the sedimentation of fine woody debris. Some short shoots of grass and herbaceous plants however do exist. Pondweed emerging to the surface and coontail in shallower sections were noted prior to inundation. Pond area was inundated before the end of June (666.2 ± 0.2 m).

ENHANCEMENT POTENTIAL: none to low; the lack of emergent vegetation (eg. sedges) and a basically barren shoreline associated with the early reservoir inundation makes the site unsuitable for nesting cover and limits its capability as a feeding area. Blasting holes in the fen area may provide some water but water quality and inundation would most likely render the site unsuitable.

TUTU D:

INVENTORY: none observed.

SITE CHARACTERISTICS: a 1.8 ha gently sloping area moderately covered by various grass species. Willow is present further up the shore. Soil properties involve a thin duff later (< 8 cm) over a sandy-silt base. The area began to be inundated at approximately 667 m.

ENHANCEMENT POTENTIAL: none; poor vegetation production and water retention capabilities make the site unsuitable for any practical enhancement. The site may provide minor goose forage but the poor soils cause very low plant productivity.

TUTU E:

INVENTORY: none observed; an old beaver house is located on the island and geese droppings were noted along parts of the upper shoreline.

SITE CHARACTERISTICS: a 2.9 ha floating island within a 7 ha bay adjacent to the Tutu Bay outlet channel. During May and the first two weeks of June (< 664 m) the reservoir had no effect on Tutu E, resulting in the "island" laying on the bay's floor with a stagnant, interior waterbody. Outside the island's sedge-sphagnum perimeter was a border of fine woody debris (floor sediment) before the thinly grassed shoreline began. However, upon inundation (≥664 m) the mat/island rises and the site transforms into a freshwater sedge-grass site.

ENHANCEMENT POTENTIAL: low to none; unfortunately the water level does not adequately inundate the site until after the nesting stage but the area could still be utilized for a loafing and feeding site for fall migrating waterfowl. Seeding the upper shoreline for geese forage may be beneficial but reservoir levels > 669 may create an obstacle for the long term production of this area.

TUTU F, G, H AND J:

INVENTORY: 2 CAGO were found feeding beside the creek at Tutu G on May 16.

SITE CHARACTERISTICS: shrub-carr areas (<2.0 ha) situated on the upper foreshore along the east side of Tutu Bay. Site vegetation comprised small patches of sedge within a hummocky, grass area. Soil profiles from the sites show a layer of organic (≤30 cm) over a mixture of fine mineral soils (eg. silt, sandy-silt, silty-clay). Shrubs (≤2 m) are scattered throughout, willow being the most prominent species. Alder, aspen, birch and black cottonwood are also present. Tutu F did retain some shallow (< 15 cm) surface water until mid-June. Unlike the other 3 sites, Tutu H features a moderately dense shrub stand (< 1 m). Tutu H has no stream but receives surface and ground runoff from a black spruce-scrub birch area. Tutu F, G and J all have a small stream running through them. The stream at Tutu G retains the greatest flow through the summer. The small depressions that dot these sites accumulate water through snowmelt, ground seepage and/or higher reservoir levels (>670 m). Reservoir levels begin to inundate the lower sections of these sites at 668m.

ENHANCEMENT POTENTIAL: low to moderate. The tall grasses present provide suitable upland nesting cover and the reservoir levels would not effect these nest areas until mid-summer when ducklings are off the nest. However, the limiting factor is the lack of brooding and dabbling sites. The bay area provides no feeding opportunities due to the deficiency of aquatic vegetation and scarcity of suitable adjacent wetlands. Some dabbling areas are created when the reservoir begins to inundate (≥ 668 m) the lower reaches of the grassy shoreline. Although negligible upland waterfowl production occurs, these sites can provide excellent foraging grounds for geese. To enhance the sites, burning programs and, if necessary, seeding programs could be implemented to produce preferred forage species. Burning alternate locations on a 3 to 5 year rotation should provide sufficient foraging areas. An active bald eagle nest at Tutu G and the additional 2 immature eagles in the bay area may influence nesting waterfowl.

TUTU I:

INVENTORY: a pair of BUFF were observed in May and a female was still at the site on June 20, however, no brood was observed.

SITE CHARACTERISTICS: a 0.6 ha sphagnum-scrub birch bog with a black spruce-horsetail perimeter. Behind, and partially intermixed with the black spruce, is trembling aspen and birch. Buckbean, grasses and some willow also fringe the open water. Pondweed and yellow waterlily provide some submergent vegetation at the site. An outlet creek exists along its western side and flows west into Tutu Bay. At present an old beaver dam minimizes this flow.

ENHANCEMENT POTENTIAL: low; no real enhancement opportunities other than installing a couple of nestboxes for BUFF and other possible cavity nesters (eg. goldeneye).

TUTU K:

Inventory: none observed.

SITE CHARACTERISTICS: a 2.8 ha bay within the largest island in Tutu Bay. Moderately grassed banks gently slope down into a sparsely grassed bottom. Many old stumps decorate the basin. Both the east and west upland areas are bordered by tall (7-10 m) alder and willow. The basin fills and drains freely with the high and low water levels due to the wide opening at the north end. Inundation of this bay begins at levels above 665m.

ENHANCEMENT POTENTIAL: none to low; water retention is the main concern. The wide drainage opening and the elevation of the basin associated with sandy-silt soil prevents this site from having potential for damming or water retention capabilities. The possibility of burning and/or seeding the basin may provide goose forage but reservoir levels reaching 672 m would most likely retard growth.

TUTUL:

INVENTORY: a pair of CAGO and GWTE and as many as 5 COME were observed loafing on the booming logs in the first weeks of May.

SITE CHARACTERISTICS: an inlet from Willistion Lake that receives water from both Tutu Creek and Tutu Bay. At low water levels ($\leq$663) it is bordered by steep (50-80%) slopes of coarse mineral soil. At higher levels ($>$ 664 m) it begins to invade the lower section of Tutu Creek and connects Tutu Bay over a wider expanse than what the deep channel from Tutu Bay normally provides. Flat adjacent uplands and high water levels ($>$ 667 m) also make this area a useful log booming and sorting area.

ENHANCEMENT POTENTIAL: none; lack of vegetation, steep banks and log booming on the site limit the waterfowl capability. The only foreseeable use of the site is for loafing.

TUTU BAY:

INVENTORY: occasionally CAGO were observed feeding and regularly droppings were found along the eastern foreshore of the bay. However, after June 12 no geese or fresh droppings were observed. A pair of COLO were viewed nesting on the barren island (north of Tutu K) up to June 20 (665 m), however prior to the next

observation period the island had become almost fully submersed (667 m). It is unknown if the COLO were able to successfully hatch a brood. The only other waterfowl species observed in the bay area were a pair of AMWI and HOME loafing on May 16 and two female BUFF loafing on June 20.

SITE CHARACTERISTICS: a bay approximately 220 ha in size with more than 7 km of shoreline created by the Williston Reservoir. A layer of fine woody debris (5-20 cm) covers the silt base in the lower sections of Tutu Bay prior to flooding. The side banks are characterized by thin organic layers and exposed mineral soils (silt, sand) resulting from the wide fluctuations in water levels and wave action. The upper shoreline has a mixture of grasses, herbaceous plants (eg. fireweed, boreal aster) and shrubs (eg. willow, alder, birch). The western shores are generally steeper (20 to 40%) with a higher degree of exposed mineral soils whereas the eastern foreshore exhibits grassed, gentler slopes (10 to 20%). The four pseudo-islands within Tutu Bay have similar shores as the western shoreline. When water levels are < 667 m the 3 smaller islands are continuous with the mainland surrounding Tutu Bay. The largest island only becomes truly isolated from the mainland at water levels exceeding 668 m. Tutu Bay retains water year-round but becomes inundated by the reservoir at levels above 664 m. Five small inlet creeks and runoff from upland areas also provide a water source. Only the narrow, steep-sloped channel at the northern end drains water from the bay. A general lack of emergent and submergent vegetation in the bay area is attributable to the broad fluctuations in water levels. The surrounding upland timber contains mixed and varying stands of aspen, spruce, lodgepole pine and birch. A water quality sample from mid-August revealed a pH of 7.7, alkalinity of 85.5 mg/L $CaCO_3$, and hardness of 85.5 mg/L $CaCO_3$.

ENHANCEMENT POTENTIAL: low to moderate. The two smaller deciduous islands and the deciduous strips that border Tutu K on the largest island could be slashed or burned. This would remove the restricting deciduous growth for a few seasons and thus allow foraging for geese. But more extensive means would likely be required to eliminate their growth for the long term. Following burning seeding may be necessary. The establishment of geese nesting islands in sheltered areas of the bay would hopefully attract breeding geese. Associated with island placement, grass burning programs would supply lush new food source. There is potential for some light broadcast burns along the eastern shores that have tall mature grasses (see Tutu F, G, H and J comments). The placement of nesting islands within the bay area leads to three difficulties: (1) an anchoring system able to fluctuate with the large drawdown (up to 10 m), (2) keeping nest material on the island when strong winds and large waves occur, and (3) survival of the island during spring break-up. Modified versions of these islands may be utilized as loon nesting sites; one anchored to the barren island in the bay may provide the conditions required to produce a successful brood.

4.2 Mugaha Bay Wetlands

MUGAHA A:

INVENTORY: see Tables 1 and 2. A pair of COLO were seen regularly and eventually hatched two young in late June. The 2 pairs of CAGO and their broods were seen feeding along the grass shoreline on the east side. A beaver was observed on two occasions; a beaver house is present in the northwest corner of the lake. A single TRSW fed at the site on two occasions. A very heavy accumulation of geese droppings were observed on the small peninsula at the north end of the lake.

SITE CHARACTERISTICS: a 11.0 ha overflow lake with a shallow open water, sedge finger (2.1 ha) on the east side. Overflow exits via culverts in the southwest corner but only occurs at very high water levels; no outflow was observed during the study period. Water comes exclusively from runoff as no inlet stream enters Mugaha A. Submergent vegetation (pondweed, coontail, waterlily) was abundant 5-10 m from shore, and the small bay between the peninsula and mainland exhibits a dense growth of smartweed. Sparse vegetation near the shoreline was a consequence of the exposed coarse mineral soil. Horsetail and grass make up a narrow ($\leq$4 m) foreshore zone on the north, east and west shores while an open shrub-grass area with short stumps and wood debris characterizes the southern shore. Upland forested areas contain lodgepole pine and spruce on the west and east shores and aspen, bir ch and spruce on the north shore. The northern peninsula has a stand of lodgepole pine snags with a thin ($\leq$5 cm) organic layer over a sand-silt base. Shoreline logs and large woody debris provide loafing sites. Two small floating mats are present in the south area of the lake; one of which was nested on by a pair of COLO. As water levels lower from evaporation, and probably seepage, these mats become more prominent. The site was inundated by the reservoir in the mid-1970's (Tuck, pers, comm.) but it is unlikely that it will re-occur as these levels exceeded the maximum pool level allowed. Water quality test in mid-August showed a pH of 9.0, alkalinity of 68.4 mg/L $CaCO_3$, and hardness of 51.3 mg/L $CaCO_3$.

ENHANCEMENT POTENTIAL: moderate. Placement of a floating island and nestboxes would increase the likelihood that CAGO and cavity nesting waterfowl (BUFF and goldeneye) would nest at the site. If Mugaha A could not provide the necessary requirements for a brooding area the marshy habitat at Mugaha B is nearby. Blasting or ditching the narrow neck of the peninsula would transform it into an isolated island that would benefit geese for nesting, grazing and loafing. Other waterfowl could also use it as a protected resting or loafing site. Seeding this site with grasses may provide both geese forage and upland nesting cover for dabblers. The placement of loafing logs would furnish loafing sites for all waterfowl utilizing the lake. Enlarging and increasing the height of the small island mats and possibly seeding them with grass would produce isolated islands for nesting CAGO or other waterfowl. However, wave action may cause erosion. Level ditching the eastern sedge finger would supply enhanced brooding areas and dabbling and muskrat habitat. Since the site has negligible damming potential, the ability to retain more water is suspect. A light broadcast burn of the southern foreshore could enhance the grazing suitability

for geese and planting deciduous saplings along the northern shore may help establish a beaver colony in future years.

MUGAHA B:

INVENTORY: see Figure 3 and Tables 1 and 2. Mugaha B was the most frequented wetland in the study area. A gradual decline in numbers and species was noticed in May, while June counts remained fairly constant (Figure 3). The stable numbers in June was likely the result of breeding pairs being the primary users of the marsh. The lone deviation from this general pattern was the high MALL count on June 12. It is believed that a major portion of this group (16; 9 males and 7 females) were subadults and only using the site to feed. A single muskrat sighting was noted in mid-May and sign of muskrat feeding was evident on the few cattails that speckled the site.

SITE CHARACTERISTICS: a 18 ha marsh with abundant emergent and submergent plant species. The deeper open water areas appear to reach a maximum depth of 2.5m, yet, 80% (estimated) of the open water area was < 1 m in depth. In spring and early summer the site had a continuous waterway from north to south but by mid-July shallower sections had become void of surface water thereby resulting in two smaller waterbodies, one at either end. Areas of Mugaha B that had become void of surface water revealed that a 10 - 30 cm accumulation of well decomposed organic matter is a top a silt-clay base. In recent years the site has been unaffected by reservoir levels though it has been inundated by the reservoir at water levels near the maximum of 672 m. Mugaha B receives water via snowmelt, ground seepage, and overflow from Mugaha A. Mugaha B's water level is therefore highly dependant on the previous years snow pack. There is no outflow creek but water appears to exit via seepage and evaporation. Large water sedges make up the greatest portion of the emergent vegetation but spike-rush and grasses are also common. Cattails only exist as a trace species. Marsh cinquefoil was an abundant plant in the southern section of the marsh. The dominant submergent plant species were pondweeds, water smartweed and coontail. Aquatic or emergent vegetation less abundant included burreed, mare's-tail, water buttercup, spring water-starwort and duckweed. Invertebrates (surface and subsurface) were abundant and diverse. Uplands bordering the eastern and southern sections of Mugaha B involve a grass-shrub area with numerous small stumps and wood debris; the result of clean-up logging for the reservoir. Logs and wood debris that were left lining the shore are used as loafing sites by waterfowl. Black spruce is the primary species vegetating the uplands of the western shore while a mixed stand of lodgepole pine and aspen lines the northern shore. Logging plans of Finlay Forest Industries indicate that a road is proposed to access timber between Mugaha Bay and Williston Reservoir for 1993. The proposed road development appears to pass near the southern end of Mugaha B, which could produce a disturbance problem for nesting waterfowl.

ENHANCEMENT POTENTIAL: moderate to high; even though Mugaha B presently has the best waterfowl habitat (feeding, nesting and brooding) within the study area and caters to both dabblers and divers, the lack of sufficient water depths and the

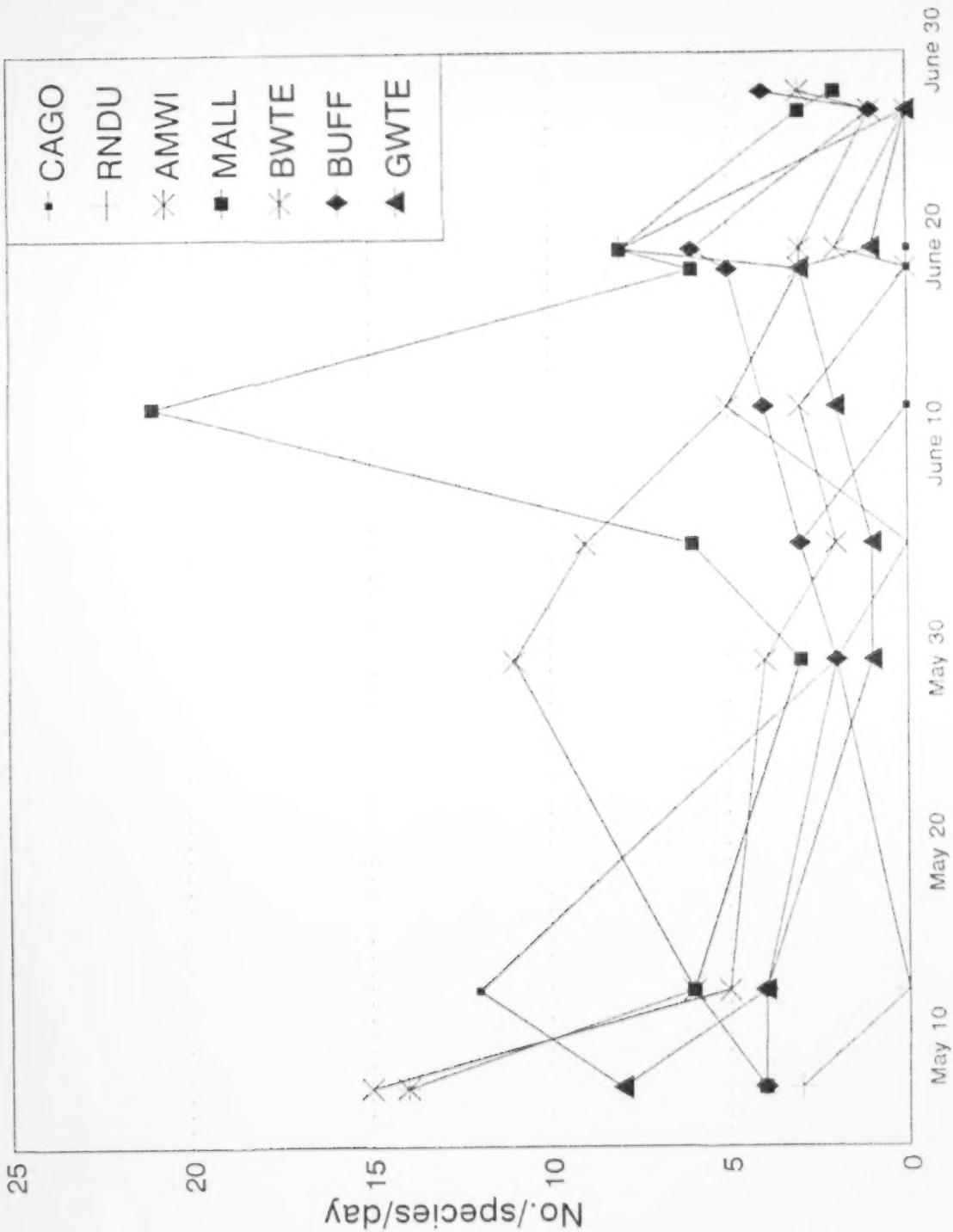

Figure 3. Principal waterfowl species frequenting Mugaha B, May - June, 1991.

encroachment of emergent vegetation in the southern half also make it a site with high enhancement potential. The creation of open waterways through portions of the dense sedge by level ditching will develop a greater edge effect and therefore provide feeding and escape habitat for waterfowl broods and adults. Nesting or loafing can take place on the earthen mounds that are a product of the ditching. Muskrats would also benefit from the earthen mounds. Deepening some open water areas through blasting or pimpling would help maintain sufficient water depths throughout the summer and at the same time provide feeding areas for diving ducks. Deeper depths will also help muskrats avoid being frozen out during the winter months. The introduction of a cattail seeding or planting program would ensure a preferred food species is available to muskrats as well as provide nesting and escape cover for waterfowl. The maintenance of a muskrat population at the site would not only be beneficial to trappers but also to the site itself as muskrats aid in reducing the encroachment by emergent vegetation and serve as a means of creating, or maintaining, open waterways. Although the site lacks suitable offshore loafing areas it can be corrected by installing loafing logs or hay bails in the open water areas. Creating earthen mounds would also serve the purpose. If balls are utilized they can also act as isolated nesting sites for CAGO and ducks requiring similar nesting habitat. Nestbox placement along the northern shore would help ensure suitable cavity nesting sites for BUFF and goldeneye. By removing some of the logs and wood debris in the eastern and southern sections some suitable upland nesting habitat would be created. Since Mugaha B not only provides habitat for a variety of waterfowl but also for moose, muskrats and many other bird species (eg. greater Yellowlegs, Bonaparte's gull, swallows) it would seem appropriate to establish a viewing sign and/or platform for the public. The most logical site for the platform would be along the eastern shore near the finger of deciduous vegetation that extends out towards the marsh.

MUGAHA C:

INVENTORY: see Tables 1 and 2. Geese were seen frequently foraging on the newly emerging grasses of the southeast corner.

SITE CHARACTERISTICS: a 9.5 ha marsh with similar emergent and submergent vegetation as Mugaha B (see above). The bottom soil characteristics were also very similar, however some regions of Mugaha C did have organic accumulations as high as 50 cm. Mugaha C has begun to be overgrown with emergent vegetation but 3 to 4 pockets still provide shallow (< 1 m) open water for waterfowl. An overabundance of logs and wood debris has reduced the open water available in many of the areas, especially at lower water levels. Even though the logs provide loafing sites they are too numerous and therefore make the areas involved virtually impassable. Small natural earthen islands of grass and sedge rise above the water table and provide some partially isolated nesting sites. Nesting sites are also available in the tall grasses and sedges that line the shores. Cavity nesting waterfowl are limited to the forested stands of aspen, lodgepole pine and spruce (northeast and northwest corners) and the snags that surround the southern tip. The snags are a consequence of past

flooding and not from heart rot, thus making them less suitable for cavity formation. An earthen mound and some logs, leftovers of reservoir "clean-up" logging, act as a crude dam at the southeast corner. Water of minimal flow was noted seeping from this dam in May. A shrub-carr upland with a variety of grasses and shrubs (< 2 m) characterizes the eastern and northern perimeter of the site. The uplands along the western shore has a similar shrub-carr vegetation but also has a high density of logs and wood debris. The primary source of water for Mugaha C evidently conies from snowmelt and ground seepage. The reservoir does not appear to inundate the site unless water levels are exceeding 670 m, which has not occurred in the past several years.

ENHANCEMENT POTENTIAL: moderate; emergent vegetation encroachment, insufficient water depths and an overabundance of wood debris associated with the high capabilities of the site ideally suit Mugaha C for enhancement. The use of level ditching would create a network of interconnecting open water channels combined with many nesting islands isolated from the shore. Associated with the formation of level ditches, a dam could be established in the southeast corner to provide greater control of the water level. However, dam construction possesses a problem as a dam over 200 m in length would be required (VERY constly!). The dam could be incorporated into the building of the logging road by Finlay Forest Industries that will access timber between Mugaha Bay and Williston Reservoir in 1993, though this depends on the extent of road construction. Further, seeding with cattails would help increase a favourable food source for muskrats at the same time as provide cover for ducks. The removal of wood debris from the site would provide less hindered passage through the open water areas, as well as provide some nesting sites along the shore. Yet, leaving a few offshore loafing logs would help alleviate the overuse of natural nesting islands as loafing sites. The snags and forested stands on the perimeter of the site provide suitable locations for nestbox placement. Light burns in parts of the adjacent shrub-carr areas would provide increased foraging for visiting geese. Blasting or level ditching the natural depressions off the southwest corner of Mugaha C could provide another hectare of habitat for waterfowl. A seeding program would probably be required to establish preferred aquatic and emergent plant species.

MUGAHA D:

INVENTORY: a hen MALL and drake COME were seen on different occasions early in May. Old beaver sign is evident on the lower reach of Morfee Creek (east side of road).

SITE CHARACTERISTICS: a 8.5 ha area that includes the intersection of Mugaha and Morfee creeks. The Morfee Creek section involves a channel with an adjacent floodplain. Past beaver habitation has left alder, red osier dogwood and black twinberry as the predominant vegetation. Mugaha Creek's upper banks compose primarily grasses with willow and other deciduous shrubs intermixed. Reservoir inundation does not appear to influence the site until levels exceed 669 m, but spring freshets appear to flood the area yearly.

ENHANCEMENT POTENTIAL: none to low. The only section that warrants enhancement consideration is the side channel on the west side of Mugaha Creek. Widening and deepening this channel may provide some feeding and loafing sites. However, the water table appears to be regulated by Mugaha Creek, which may pose a water retention problem. Burning the grassy shoreline of the creek would likely provide geese foraging areas.

MUGAHA E AND F:

INVENTORY: a pair of CAGO and 5 HOME at Mugaha E and a pair of GWTE at Mugaha F were observed loafing on May 22 when both sites were isolated ponds.

SITE CHARACTERISTICS: 1.5 ha (Mugaha E) and 0.8 ha (Mugaha F) exposed ponds that abut against the forested shoreline of northeast Mugaha Bay. Steep (> 60%) mineral slopes make up their eastern shoreline while the remaining shoreline is part of the Mugaha Bay basin. The low elevation and wide mouth of each site cause them to be flooded easily as the reservoir rises. Inundation occurs at approximately 664 m. Vegetation production is very low, but some grasses and horsetails occur on the upper banks of the east side. The lower shoreline is similar to the Tutu C pond that has an accumulation of fine woody debris around its perimeter at lower water levels.

ENHANCEMENT POTENTIAL: none; limited vegetation and very limited potential for vegetation production along with an early inundation by the reservoir (> 664 m) make these sites unsuitable for all waterfowl activities except loafing.

MUGAHA G:

INVENTORY: see Tables 1 and 2. Geese droppings were common along most of the foreshore until the first week in June. The COLO pair was nesting until June 5 but for unknown reasons aborted their nest; no eggs were observed. Two adult beaver were observed on three occasions. A beaver house is present on the west shoreline.

SITE CHARACTERISTICS: a 7.3 ha lake with abundant submergent vegetation (pondweed, waterlily, milfoil, coontail). A grass-shrub upper slope levels out onto a 2 to 5 m grass-sedge shelf next to the water's edge. Horsetail was another common shoreline plant. Sedge was common in the southwest and northeast corners. Pondweed, coontail and waterlilies vegetate the shallower zones of the lake. Water depths reach 5 to 6 m. A mature stand of spruce, aspen and birch surround the lake except for the southwest corner and a patch along the east side. The southwest corner is an open area that accesses Mugaha Bay while the eastern area is a strip of deciduous trees (≈ 8 m) that separate Mugaha G from the Parsnip West road. Logs and woody debris provide loafing sites in the northwest and southeast corners. Invertebrates (eg. dragonflies, damselflies, waterstriders) and fish (<7 cm) were abundant along the convoluted shoreline. Shells of freshwater mussels were also observed on the shore. A negligible water flow exits Mugaha G in the southwest corner and enters Mugaha H. The site is unaffected by the reservoir until levels exceed 669 m.

ENHANCEMENT POTENTIAL: moderate to low; the lack of dense emergent vegetation along most of the lake's edge lessens the suitability for over-water nesting waterfowl and the narrow grass area provides little upland nesting sites. However, the

installation of an artificial island and nestboxes would hopefully increase the nesting habitat for some waterfowl species. Although aspen and birch are common upland species, nestbox introduction can still prove beneficial. Logs and wood debris provide suitable shoreline loafing sites but the addition of offshore loafing sites would provide greater protection from predators (eg. coyote, mink, fox). The lake is sufficiently deep for muskrats and beaver to avoid winter ice conditions but the in adequate amounts of sedge and other emergent vegetation tend to reduce muskrat suitability. Conversely, the presence of suitable upland forage such as aspen, willow and black cottonwood along with the observation of two adult beaver indicate the site has year-round beaver capabilities. Planting saplings of these three deciduous species would surely create a healthier and longer beaver occupancy.

MUGAHA H:

INVENTORY: 2 hen MALL, a pair of RNDU and a COLO (an individual probably from Mugaha G) were observed loafing and, too a minimal extent, feeding prior to the inundation at a water level of 663.6 $\pm$ 0.3 m.

SITE CHARACTERISTICS: a 5.6 ha pond very similar to Tutu C and Mugaha E and F. This pond of the Mugaha basin has moderately sloped (10-30%) mineral banks on two-thirds of its circumference. The remaining third is a wide slow grade that allows water to freely regulate with the reservoir. A fine woody debris layer (< 15 cm) covers a silt base. Mugaha H receives some water from Mugaha G via a short overflow creek.

ENHANCEMENT POTENTIAL: none; early inundation (>663 m) and lack of shoreline and aquatic vegetation make it an unsatisfactory site for enhancement.

MUGAHA I:

INVENTORY: a pair of MALL were feeding at the site in the first week of May where a shallow surface water area (< 20 cm) provided dabbling habitat amongst the sedge and grasses at the north end.

SITE CHARACTERISTICS: a 1.0 ha sedge-sphagnum-grass marsh. A small boggy sphagnum and buckbean area centers a wet organic, sedge-grass perimeter. Willow and water cinquefoil are also fairly common. The upland plant species consist of a fringe of aspen and willow (< 3 m) and then a stand of lodgepole pine, spruce and aspen. The site is self contained except for a small overflow outlet at the southwest end that drains into Mugaha Bay. There was no outlet flow noticed and it appears that the reservoir does not inundate the site. Water accumulation seems to occur only from snowmelt. The site was still very wet even after the third week of June. Logs and woody debris line the upper perimeter.

ENHANCEMENT POTENTIAL: none; the relative small size and the excavation and removal of material required to produce a suitable waterfowl area would be very, very costly. The only foreseeable use of the site is for dabblers in early spring when there is sufficient surface water for feeding.

MUGAHA J:

INVENTORY: 5 CAGO (2 pair, 1 individual) were observed at the site on May 23; 1 nest had 2 eggs. Further to this date no waterfowl were seen utilizing the area. Recent beaver activity was evident from the felled aspen on the adjacent shores.

SITE CHARACTERISTICS: a 3.1 ha area of slow moving water paralleling the Parsnip West road at 6.5 km. The upper section was characterized by scrub birch and sedge growing amongst shallow (< 30 cm) standing water. Invertebrates were numerous. The lower section involved an open water area bordered by dense grass and sedge. Two grass islands were present within the open water; one housed a CAGO nest. The site is not effected by the reservoir but beaver dams do control the water level. Many of the downstream beaver dams were pulled. Upland vegetation includes willow, black spruce, spruce and aspen.

ENHANCEMENT POTENTIAL: none. Protecting the beaver dams from being pulled will hopefully ensure adequate water levels.

MUGAHA BAY:

INVENTORY: the only waterfowl observed using the Mugaha Bay area was a group of 22 loafing WWSC, 14 shoreline feeding CAGO (May 23) and a pair of loafing AMWI (May 8).

SITE CHARACTERISTICS: the bay is characterized by a wide basin with steep (30-60%), sandy shores (east and west). The northern section is identified by the slow, gradual climb (5-15%) into Mugaha C and a northern shrub-carr area near Mugaha D. Mugaha Bay's water level is directly connected to the reservoir at all times, unlike Tutu Bay. Upon reservoir filling the bay area is slowly but surely inundated over the basin's wide flat basin. The bay also receives water from Mugaha Creek at its northeast corner and from Mackenzie's sewage treatment facility in the south. Mugaha Creek flows within a defined channel along the eastern side of the basin during low reservoir levels.

ENHANCEMENT POTENTIAL: low to none. The steep, narrow, minimally vegetated shoreline of the east and west shores have no practical enhancement opportunities; however the adjacent uplands of the western banks could be logged in small sections and seeded for geese foraging sites. Light broadcast burns may enhance parts of the northern shrub-carr area. But, if any enhancement is to be carried out within the Mugaha Bay area see enhancement recommendations for adjacent wetland areas (Mugaha A, B, C and G).

4.3 Lakes Area Wetlands

LAKES #1 AND #2:

INVENTORY: a drake MALL and a pair of RNDU were observed loafing on Lake #1 in mid-May, and a female GADW and a pair of CAGO were observed on Lake #2 on May 23. There was no sign of active nesting at Lakes #1 and #2 but the CAGO pair at Lake #2 had 2 Class IA goslings.

SITE CHARACTERISTICS: Lakes #1 (6.1 ha) and #2 (14.0 ha) are forested (spruce, birch,

subalpine fir, lodgepole pine) virtually to their waters edge. A narrow fringe (< 2 m) of alder and willow grow beside a sandy shore of horsetail, grass and the occasional patch of sedge. Submergent vegetation is almost non-existent except for the spotty appearance of waterlilies along the narrow shelf (2-3 m) before the water depth drops off. These drop-offs result in rather deep waterbodies and relatively poor invertebrate populations. Lake #2 is connected to Lake #3 by a channel at their northwest and northeast corners, respectively. Both sites acquire their water via the surrounding uplands; Lake #2 also receives water from Lake #3 and a small creek from Lake #4. A small marshy area is located at the northern tips of both lakes. Water samples indicated values of 7.5 for pH, 51.3 mg/L $CaCO_3$ for alkalinity, and 51.3 mg/L $CaCO_3$ for hardness [Lake #1]; and 8.2 for pH, 102.6 mg/L $CaCO_3$ for alkalinity, and 102.6 mg/L $CaCO_3$ for hardness [Lake#2].

ENHANCEMENT POTENTIAL: low. A narrow shoreline and steep upland slopes associated with the lack of suitable soils make both locations inappropriate for enhancement.

LAKE #3:

INVENTORY: late in June a single female BUFF was observed feeding. Three otters were observed feeding on freshwater mussels along the shore on June 27. Beaver activity was noted at the dam at the northern end. Freshwater mussel shells on the shoreline and the worn trail, in the creek bed that runs north from the beaver dam to Tutu Bay, indicated river otter use.

SITE CHARACTERISTICS: a 2.7 ha lake regulated by a beaver dam at its northern tip. This lake is in a more advanced stage than Lakes #1 and #2. A 2 to 3 m grass shoreline with an alder and willow border encircles the site. Upland species are similar to Lakes #1 and #2. Organic matter covers the lake floor providing a suitable base for waterlily and pondweed. Due to the greater organic accumulations, shallower depths and submergent vegetation Lake #3 also harbours a much larger invertebrate population than Lakes #1 and #2. Lakes #2 and #3 are connected via a 60 cm channel at their northern ends. Beaver activity at the dam site had elevated the water level on both lakes by 15 cm within the month of June. A water sample revealed a pH of 1.1, an alkalinity of 102.6 mg/L $CaCO_3$ and a hardness of 85.5 mg/L $CaCO_3$.

ENHANCEMENT POTENTIAL: low to none; enhancement at this site would be restricted to nestboxes because of its size, accessibility and limited amount of shoreline.

LAKES #4, #5 AND #6:

INVENTORY: see Tables 1 and 2. An old beaver house was noted along the east side of Lake #4.

SITE CHARACTERISTICS: Lakes #4, #5 and #6 are bogs with the characteristic acid-tolerant vegetation of sphagnum moss, scrub birch, Labrador tea and buckbean. Lake #6 (1.1 ha) is an advanced bog and has only a 30-50 m^2 area of open water which is partially vegetated with grass. Lakes #4 (1.5 ha) and #5 (8.1 ha) are less advanced as the presence of waterlilies, pondweed and fish (chub) indicate. The grass-sphagnum shelf surrounding the water's edge also has some sedge. Upland plant

species consist of a black spruce perimeter with birch, spruce and lodgepole pine stands further upland. Lake #5 has two separate open water areas. The smaller (0.5 ha) sedge-bordered pond connects to the main (5.8 ha) waterbody by means of a wet grass-scrub birch area. Both sites receive runoff from their surrounding uplands. An outlet creek of negligible flow exits Lake #4 from the northwest and flows toward Lake #2 while the overflow or excess water from Lake #5 basically disperses through a forested spruce area off its southern end. Water quality samples a week old revealed values for Lake #4: pH of 7.2, alkalinity of 68.4 mg/L $CaCO_3$ and hardness of 51.3 mg/L $CaCO_3$. Lake #5 values included a pH of 7.8, an alkalinity of 102.6 mg/L $CaCO_3$ and a hardness of 85.5 mg/L $CaCO_3$.

ENHANCEMENT POTENTIAL: low. Lake #6 has no enhancement possibilities because of its advanced stage of bog succession. Enhancement at Lakes #4 and #5 is restricted to nestboxes and nesting islands (Lake #5) due to their inaccessibility and limited habitat. The introduction of offshore loafing logs would provide loafing areas better protected from predators.

4.4 Additional Wetlands

WILLI FEN:

INVENTORY: none. Goose droppings were noted on the lower foreshore area.

SITE CHARACTERISTICS: a 29 ha sedge and grass fen along the foreshore of Williston Lake. The lower reaches had large water sedges while further upland the plant composition changed to field sedges, water cinquefoil, willow (< 1 m) and a variety of grasses. At approximately 659 m this gently (< 10%) sloped site begins to be flooded. No surface water occurs unless the site is inundated by the reservoir. Apart from reservoir inundation the site receives groundwater from the surrounding uplands. The east and west uplands comprise a varying mix of lodgepole pine, aspen and spruce, while the southern upland is part of a black spruce-bog area. The front 5 ha of Willi Fen is utilized as a booming ground for a log salvage business on the adjacent foreshore. Soil profiles of the fen indicate that an organic layer (10 - 30 cm) overlies peat that extends > 1.5 m below.

ENHANCEMENT POTENTIAL: none; the soil characteristics of the site would provide problems with water retention and water quality if level ditching was to be employed. Also, early inundation of the site is not advantageous. The presence of goose droppings at the site indicate some foraging occurs but no enhancement seems feasible.

GATAIGA CREEK:

INVENTORY: as many as 2 pairs of RNDU and a pair of MALL were seen at the site until mid-June. A single Class IIa RNDU duckling was spotted feeding at the end of June. Muskrats were observed feeding on sedges in June. Beaver activity was also prominent in June as the culvert under the dirt road to the west of Highway 39 was blocked and the water level had risen over 0.5 m.

SITE CHARACTERISTICS: a section of Gataiga Creek that meanders from a larger open

water area towards (west) and past Highway 39 to the dirt road approximately 150 m away. This slow moving section of Gataiga Creek is densely vegetated by sedges and willow growing on elevated areas. Water smartweed and waterlilies are relatively common in the 2 to 3 m deep open water channels. Lodgepole pine is present on the uplands and black spruce invades parts of the creek.

ENHANCEMENT POTENTIAL: low to none. Due to present suitability of the site and its possible fisheries concerns the most effective and easiest enhancement that could be carried out would be the placement of nestboxes on the forested shoreline.

PARSNIP RIVER:

INVENTORY: a pair of CAGO with 5 Class IA goslings, 3 TRSW and 3 male GWTE were observed loafing on the small side channel near the 17 KM sign (May 30). A group of 17 CAGO were seen feeding along the same channel on June 12. These were the only CAGO seen within the study area past June 5.

SITE CHARACTERISTICS: a flood plain area (~180 ha) at the mouth (west side) of the Parsnip River. The site is characterized by grass and horsetail that covers a sandy-gravel area bisected many times by channels. Higher sections have some silt accumulations with the periodic willow (<2 m). Standing water in depressions and channels within the site appear to fluctuate with the level of water in the Parsnip River, a consequence of the porous soil. Geese droppings indicate use of the area as a feeding site during lower water levels. Spring freshet levels and higher reservoir levels (> 669 m) appear to inundate the site.

ENHANCEMENT POTENTIAL: none to low. The only enhancement foreseeable at this site would be to burn the grass in early spring, prior to freshet, to provide lush new shoots for migrating and brooding geese. Geese nesting at or near Site 1 could also use the site.

4.5 1990 Wetland Creation Monitoring

Sites 1 and 2 were utilized as locations to test dynamite blasting as a technique for creating suitable wetland areas for waterfowl. Both sites were monitored for water retention and waterfowl potential. Site 2 was also monitored for waterfowl use.

SITE 1 (MISCHINSINLIKA FORESHORE):

WATER RETENTION: the single-blast hole retained an observed maximum water depth of approximately 0.6 m on May 13. Gradually the level declined to a depth of 30 cm on June 19 and by July 5 no free standing water remained. The double-blast hole had a more erratic water level. From May 13 to June 19 the water level only dropped 10 cm but, by July 5, it had dropped another 40 cm. The following two weeks saw it drop 10 cm more. An observation on July 17 showed a water level of approximately 25 cm. An area of natural shallow depressions on the north side of the Mischinsinlika Creek was also monitored. During the month of May these channels held up to 0.7 m of water. However, by June 19 all were essentially void of any surface water.

COMMENTS: plant regeneration in the blasting holes was sparse and limited to the upper bank and the few grass clumps that have sloughed from the edge. Invertebrate populations were minimal; waterstriders were present at both sites and the occasional water-beetle was seen in the double-blast hole. The water was a dark tea colour at both holes. The reservoir had begun to inundate the main channel of the Parsnip River near Site 1 by July 17 (668 m) but there was no noticeable effect on the test holes. Another 1 to 2 m rise would cause the lower section of the foreshore to become inundated. An abundant growth of grasses, sedges and shrubs (<2 m) blanket this mounding foreshore area providing excellent nesting habitat for upland nesting waterfowl such as MALL, NOPI and CAGO. However, the lack of suitable brooding habitat places a limiting factor on its usefulness.

ENHANCEMENT POTENTIAL: low to none; monitoring water levels indicated that water retention does occur into the month of July at one of the test holes, albeit limited (<0.3 m). Soil conditions are the prime focus of concern as the water table fluctuates with Mischinsinlika Creek and therefore water levels are not stable. To ensure sufficient water accumulates in the ponds a back-channel or ditch could be established whereby water comes directly from Mischinsinlika Creek. This type of development may also provide rearing or wintering habitat for fish from the Mischinsinlika, though the water temperatures may pose a problem for the growth of aquatic vegetation. If any enhancement is to take place, light broadcast burns of the foreshore with or without a subsequent seeding program would create increased foraging benefits for geese.

SITE 2 (BUTH MARSH):

WATER RETENTION: when first observed (May 13) the 7 x 50 m site had essentially no surface water (<5%) while the other four sites had surface water coverage ranging from 20 to 80 %. Water depths ranged from 5 - 40 cm. On June 19 the 7 x 50 m and the two small 6 m diameter sites were void of any surface water while the two mid-sized ponds (6 x 16 m and 6 x 22 m) had coverage of 30% and 70% respectively. The water depth at the 6 x 16 m site was only 2-4 cm. By mid-July the 6 x 16 m site was down to a skiff of surface water over 15% of the area. However the 6 x 22 m site still retained 60% coverage and depths of 2 - 20 cm.

COMMENTS: a GWTE drake was observed dabbling on the 6 x 22 m site on June 19 but no waterfowl was seen at any of the other sites. Observed insect species were restricted to mosquitoes and waterstriders. This deep organic area was characterized by bog species such as sphagnum moss, scrub birch, black spruce and buckbean. Other plant species included narrow-leaved cotton-grass, sedges and horsetail.

ENHANCEMENT POTENTIAL: none; the poor water quality and deep organic nature of the site make it an unlikely habitat for waterfowl. If some of the organic material was removed from within the blasting holes a greater water depth would be attained but to what benefit is unknown.

6.0 Summary

A total of 31 wetlands were monitored within the Tutu-Mugaha study area: Tutu Bay wetlands (13), Mugaha Bay wetlands (12), and Lakes Area wetlands (6). Of these sites, only 7 showed signs of regular use by waterfowl, fewer still for aquatic furbearers. Six waterfowl species were observed most: Canada geese, American wigeons, blue-winged teal, mallards, buffleheads, and ring-necked ducks.

Breeding success was limited primarily to Mugaha B, though broods were observed at Mugaha G, Lake #2 (CAGO), and Lake #4 (BUFF). Bufflehead and geese had the highest observed breeding success in the study area; 5 and 4 broods, respectively. Geese were observed often in the initial stages of the study, but after June 12th no geese were seen. The geese vacated the study area apparently to find suitable moulting sites. It is important for these moulting areas to be identified in order to enhance or preserve these critical habitats.

Aquatic furbearers were observed in very few numbers. Beavers, the most prominent aquatic furbearer, were viewed at 4 locations and beaver sign (eg. lodges, caches) was noted at a few other sites. Only one muskrat sighting was recorded and sign was limited. It was evident that many of the wetlands examined had limited marsh habitat and/or sufficient water depths and stable levels to provide year-round habitat.

A variety of enhancement techniques are available to maintain and/or produce suitable habitat for different waterfowl types (eg. dabblers, cavity nesters) and aquatic furbearers. Utilizing these enhancement techniques would assist in meeting the provincial government's goal in wildlife management of ensuring species diversity, numbers and distribution (BC Environment, 1991). Some people are against the enhancement of so-called "less preferred" waterfowl species such as goldeneyes, buffleheads, and mergansers. But, consumptive recreational opportunities are only secondary objectives. However, through the formation of species diversity and abundance, the secondary objectives would surely benefit.

In general, Tutu Bay wetlands have low to moderate waterfowl enhancement potential and very limited aquatic furbearer enhancement opportunities. Enhancements that may be possible include spring burns of mature grass areas. Floating islands placed near these foraging sites would hopefully establish a breeding population of Canada geese in the area. Nestboxes and a floating island installed at Tutu B would likely benefit the waterfowl at this site.

The steep, exposed banks and wide water level fluctuations of Mugaha Bay prompt any enhancement aspirations in this area to be focused on the adjacent wetlands that are less effected by the reservoir. This includes the placement of nestboxes, floating islands and loafing logs at Mugaha A, B, and G.

Poor accessibility, coarse mineral soils, limited littoral zones, and forestation to the waters edge greatly restricts the enhancement opportunities in the Lakes Area. Nestboxes are likely the only possibility.

As the preceding comments indicate, most locations are limited to the placement of artificial nesting structures. Poor water stability, coarse soils, insufficient vegetation, and limited accessibility individually or collectively hamper further methods of enhancement.

7.0 Reference Material

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Canada Land Inventory. 1970. Land Capability for Wildlife - Waterfowl. Ottawa. Map 93O (Pine Pass)

Schemnitz, Sanford D. 1980. Wildlife Management Techniques Manual (4th Ed.). The Wildlife Society Inc., Washington, D.C. p. 330-402.

APPENDIX A

AIRPHOTOS FOR SITES WITHIN THE TUTU-MUGAHA STUDY AREA

LOCATION	AIRPHOTO No.
Tutu A, B, C, D & L	BCC930 - #184
Tutu E, F, G, H & K	BCC930 - #182
Tutu Bay	BCC930 - #180-184
Lake #1-6 & Mugaha A	BCC930 - #179
Mugaha B & C	BCC930 - #143
Mugaha D & E	BCC930 - #177
Mugaha F, G & H	BCC930 - #175
Mugaha I & J	BCC930 - #173
Mugaha Bay	BCC930 - #173-177 & #145-147
Willi Fen	BCC930 - #141
Site 1 (Mischinsinlika)	BCC931 - #165
Site 2 (Buth Marsh)	BCC938 - #52
Parsnip River	BCC425 - #135

APPENDIX B

WATERFOWL LAND CAPABILITY CLASSIFICATION

(Canada Land Inventory, 1970)

WETLANDS CLASSIFIED	CAPABILITY CLASS	LIMITATION SUBCLASS*
Tutu and Lakes Area wetlands (except Lake #5 & Tutu A & B)	6	T, J, Z
Tutu A and B	6	T, B
Mugaha A and Lake #5	5	J, F
Willi Fen and Mugaha B, C & G	6	T, B
Sites 1 and 2	6	T, B
Gatalga Creek	6	T, B

* All wetlands connected directly to the Williston Reservoir would also presumably have a further restriction of inundation (Limitation Subclass I).

CAPABILITY CLASSES

CLASS 5: LANDS IN THIS CLASS HAVE MODERATELY SEVERE LIMITATIONS TO THE PRODUCTION OF WATERFOWL

- Capability on these lands is moderately low. Limitations are usually a combination of two or more of the following factors: climate, soil moisture, permeability, fertility, topography, salinity, flooding and poor interspersion of water areas.

CLASS 6: LANDS IN THIS CLASS HAVE SEVERE LIMITATIONS TO THE PRODUCTION OF WATERFOWL

- Capability on these lands is very low. Limitations are easily identified. They may include aridity, salinity, very flat topography, steep-sided lakes, extremely porous soils and soils containing few available minerals.

LIMITING SUBCLASSES

Subclass B: free-flowing water — The limitation is usually due to fast or excess water flow, which inhibits development of marsh habitat along the stream edge. It may also be due to a lack of flow through low-lying land, which results in habitat of poor quality.

Subclass F: fertility — The limitation is insufficient nutrients in the soil and water for optimum plant growth.

Subclass I: inundation — The limiting factor is excessive water level fluctuation or tidal action, which adversely affects the habitat or the nesting success of waterfowl.

Subclass J: reduced marsh edge — The limitations are topographic features that adversely affect development of optimum marsh conditions along the edge of water areas.

Subclass T: adverse topography — Either steepness or flatness of the land may limit the development of permanency of wetlands.

Subclass Z: water depth — Excessively deep or shallow waters limit the development of optimum waterfowl habitat.

WATERFOWL LAND CAPABILITY CLASSIFICATION
(CANADA LAND INVENTORY, 1970)

APPENDIX C

CALCULATION OF BREEDING PAIRS FROM GROUPS (DUCKS UNLIMITED)

ALL DABBLERS

- drakes in groups of 2 or 3 each represent one pair
- groups of 3 to 6, including one female represent one pair (ie. 2/1, 3/1, 4/1, 5/1, 1/2, 1/3, 1/4, 2/3, 2/4, 4/2, 4/3, etc.)

CANV, REDH, RNDU, RUDU, SCOTERS, MERGANSERS

- groups of 3 to 6, including one female represent one pair (ie. 2/1, 3/1, 4/1, 5/1, etc.)

BUFF, GOLDENEYE

- heterogeneous groups of 3 represent one pair (ie. 2/1, 1/2)

SCAUP

- groups of 2 drakes and 1 hen represent one pair

APPENDIX D

WILLISTON RESERVOIR WATER LEVEL 1991

WILLISTON RESERVOIR WATER LEVEL (Spring/summer 1991)		
DATE	WATER LEVEL	Wkly diff.
May 1	657.52 m.	
May 8	658.15 m.	0.63 m.
May 15	659.34 m.	1.19 m.
May 22	660.79 m.	1.45 m.
May 29	662.00 m.	1.21 m.
June 5	663.05 m.	1.05 m.
June 12	664.04 m.	0.99 m.
June 19	664.96 m.	0.92 m.
June 26	666.03 m.	1.07 m.
July 3	666.92 m.	0.89 m.
July 10	667.51 m.	0.59 m.
July 17	668.03 m.	0.52 m.
July 24	668.33 m.	0.30 m.
July 31	668.51 m.	0.18 m.
Aug. 7	668.58 m.	0.07 m.
Aug. 14	668.15 m.	0.43 m.
Aug. 21	668.77 m.	0.62 m.

Minimum 1991 level - Apr. 20(657.12 m.)
Maximum 1991 level - Aug. 21(668.77 m.)

WILLISTON RESERVOIR WATER LEVEL (1979 - 1991)					
YEAR	LOW WATER LEVEL		HIGH WATER LEVEL		Drawdown
	Date	Level	High water dates	Level	
1979	April 25	655 m.	Aug. 1 - Sept. 15	656 m.	1 m.
1980	April 20	656 m.	Sept 10 - Oct. 25	666 m.	10 m.
1981	April 25	660 m.	July 25 - Sept. 10	663 m.	3 m.
1982	May 5	661 m.	Aug. 20 - Sept. 15	672 m.	11 m.
1983	April 25	667 m.	July 5 - Aug. 25	672 m.	5 m.
1984	May 15	664 m.	July 25 - Sept. 20	672 m.	8 m.
1985	May 15	662 m.	Aug. 1 - Aug. 20	670 m.	8 m.
1986	May 20	657 m.	Aug. 20 - Nov. 10	670 m.	13 m.
1987	May 1	659 m.	Aug. 10 - Sept. 10	670 m.	11 m.
1988	May 1	656 m.	July 20 - Sept. 5	667 m.	11 m.
1989	April 19	654 m.	July 20 - Aug. 1	664 m.	10 m.
1990	April 20	655 m.	Aug. 5 - Sept. 1	669 m.	14 m.
1991	April 20	657 m.	July 17 - Sept. ?	668 m	11 m.

APPENDIX E

CANADIAN WILDLIFE SERVICE ABBREVIATIONS FOR WATERFOWL

Dabblers / Upland Nesting Waterfowl

AMWI	American wigeon	*Anas americana*
BWTE	Blue-winged teal	*Anas discors*
CAGO	Canada goose	*Branta canadensis*
CITE	Cinnamon teal	*Anas cyanoptera*
EUWI	Eurasian wigeon	*Anas penelope*
GADW	Gadwall	*Anas strepera*
GWTE	Green-winged teal	*Anas crecca*
MALL	Mallard	*Anas platyrhynchos*
NOPI	Northern pintail	*Anas acuta*
NOSH	Northern shoveller	*Anas clypeata*

Divers / Over-water Nesting Waterfowl

CANV	Canvasback	*Aythya valisineria*
GRSC	Greater scaup	*Aythya marila*
LESC	Lesser scaup	*Aythya affinis*
REDH	Redhead	*Aythya americana*
RNDU	Ring-necked duck	*Aythya collaris*

Divers / Cavity Nesting Waterfowl

BUFF	Bufflehead	*Bucephela albeola*
BAGO	Barrow's goldeneye	*Bucephela islandica*
COGO	Common goldeneye	*Bucephela clangula*
COME	Common merganser	*Mergus merganser*
HOME	Hooded merganser	*Lophodytes cucullatus*

Sea Ducks

HARL	Harlequin duck	*Histrionicus histrionicus*
WWSC	White-winged scoter	*Melanitta fusca*

Others

RNGR	Red-necked grebe	*Podiceps grisegena*
TRSW	Trumpeter swan	*Cygnus buccinator*

VEGETATION TAXONOMIC AND COMMON NAMES

Trees and Shrubs:

Abies lasciocarpa	subalpine fir
Alnus spp.	alder spp.
Betula glandulosa	scrub birch
Betula papyrifera	paper birch
Picea glauca x engelmannii	hybrid spruce
Picea mariana	black spruce
Pinus contorta	lodgepole pine
Populus tremuloides	trembling aspen
Populus balsamifera trichocarpa	black cottonwood
Salix spp.	willow spp.

Emergent and Submergent Species:

Carex spp.	sedge spp.
Ceratophyllum demersum	coontail
Equisetum spp.	horsetail spp.
Menyanthes trifoliata	buckbean
Myriophyllum spp.	water milfoil
Nuphar lutea polysepala	yellow waterlily
Potamogeton spp.	pondweed spp.
Typha latifolia	cattail

Other Vegetation:

Aster borealis	boreal aster
Cirsium arvense	Canadian thistle
Epilobium angustifolium	fireweed
Eriophorum angustifolium	narrow-leaved cotton-grass

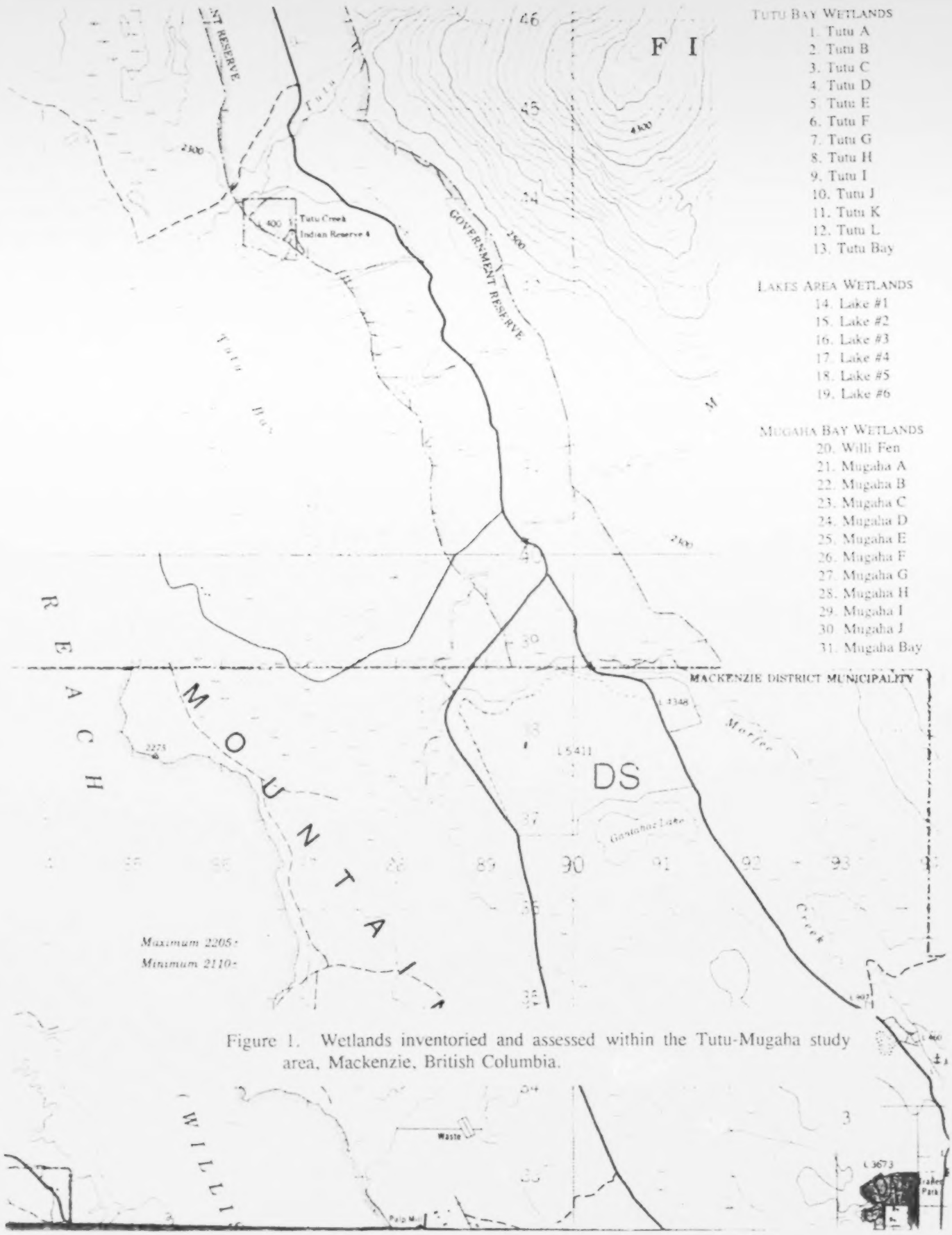


Figure 1. Wetlands inventoried and assessed within the Tutu-Mugaha study area, Mackenzie, British Columbia.

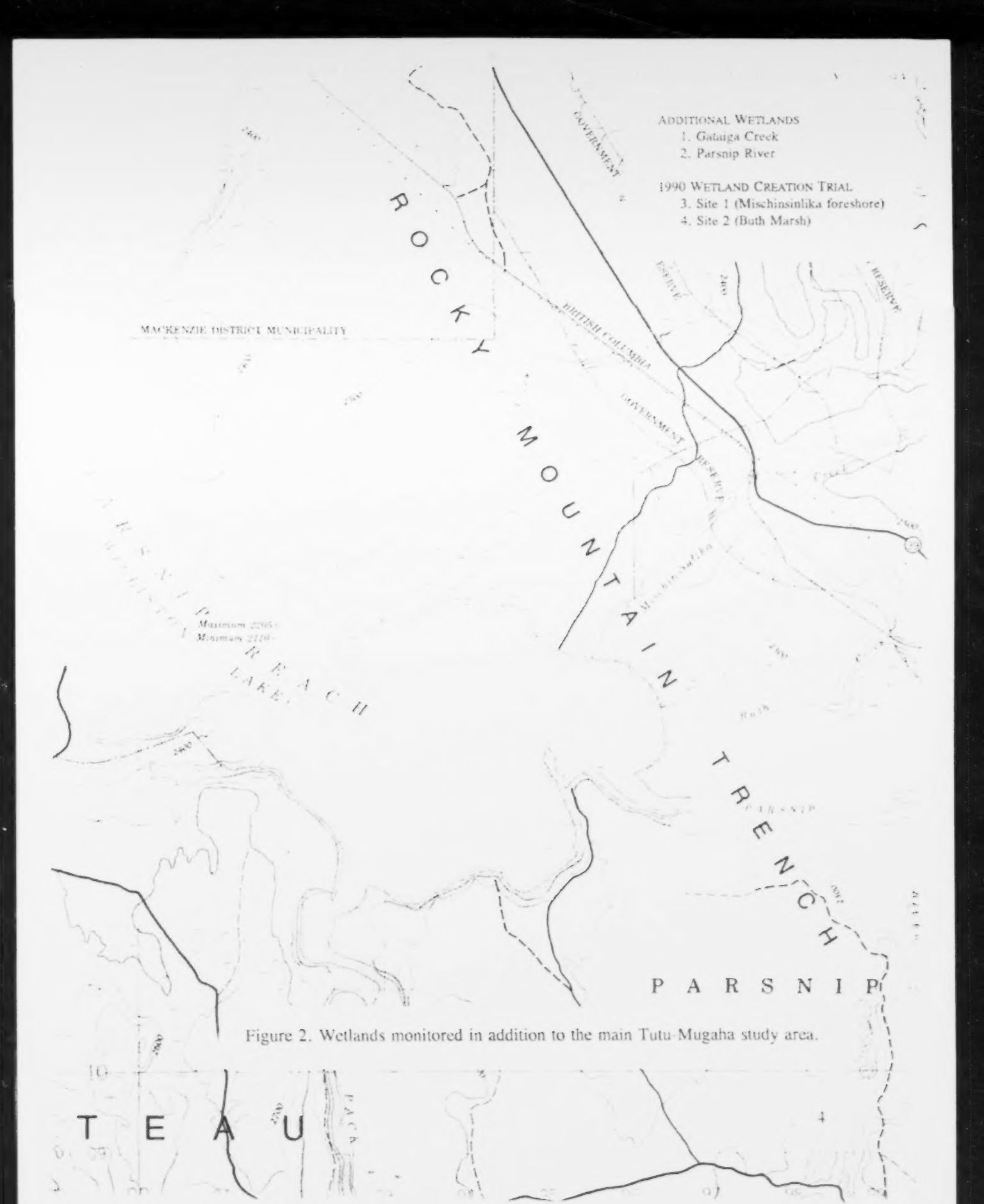
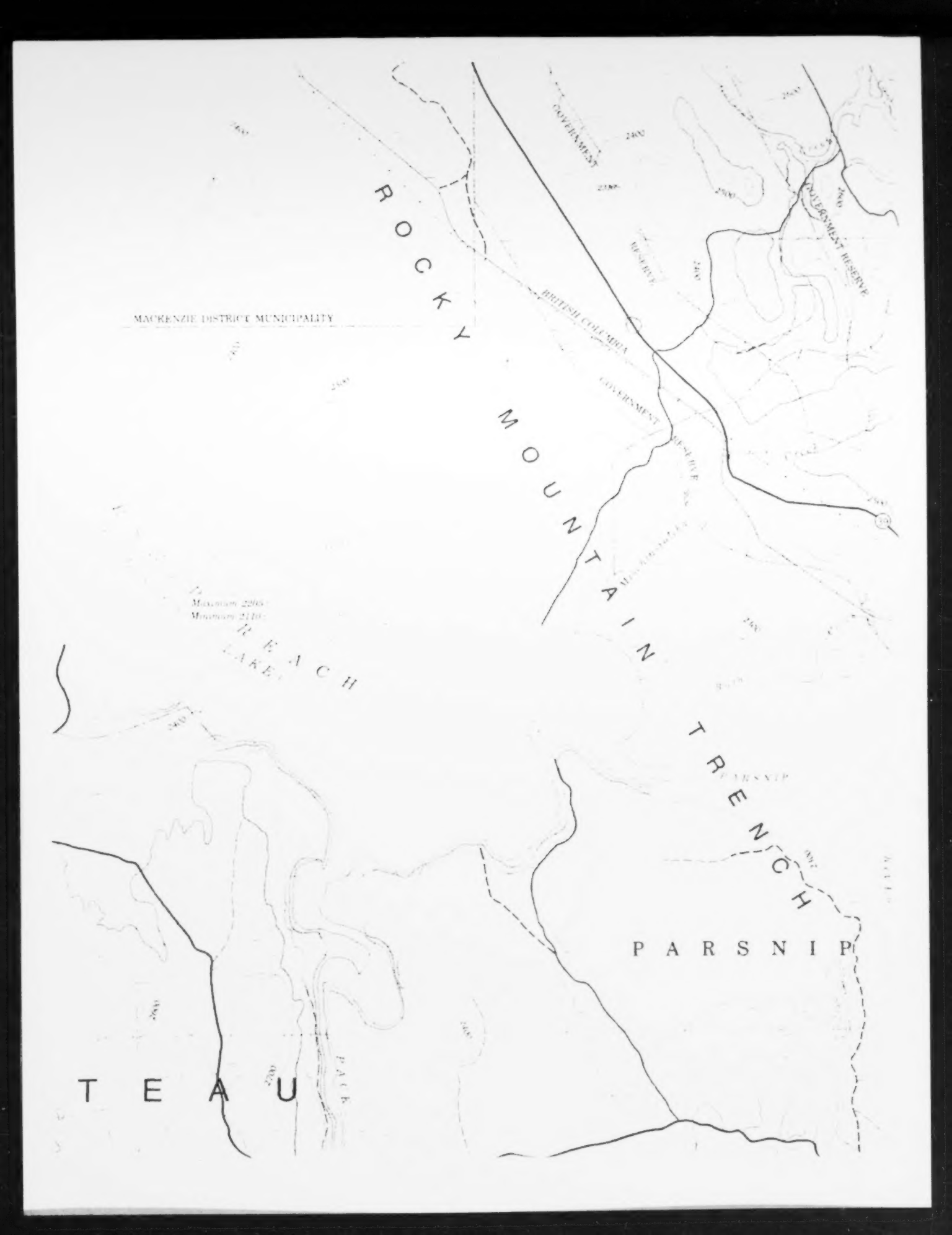
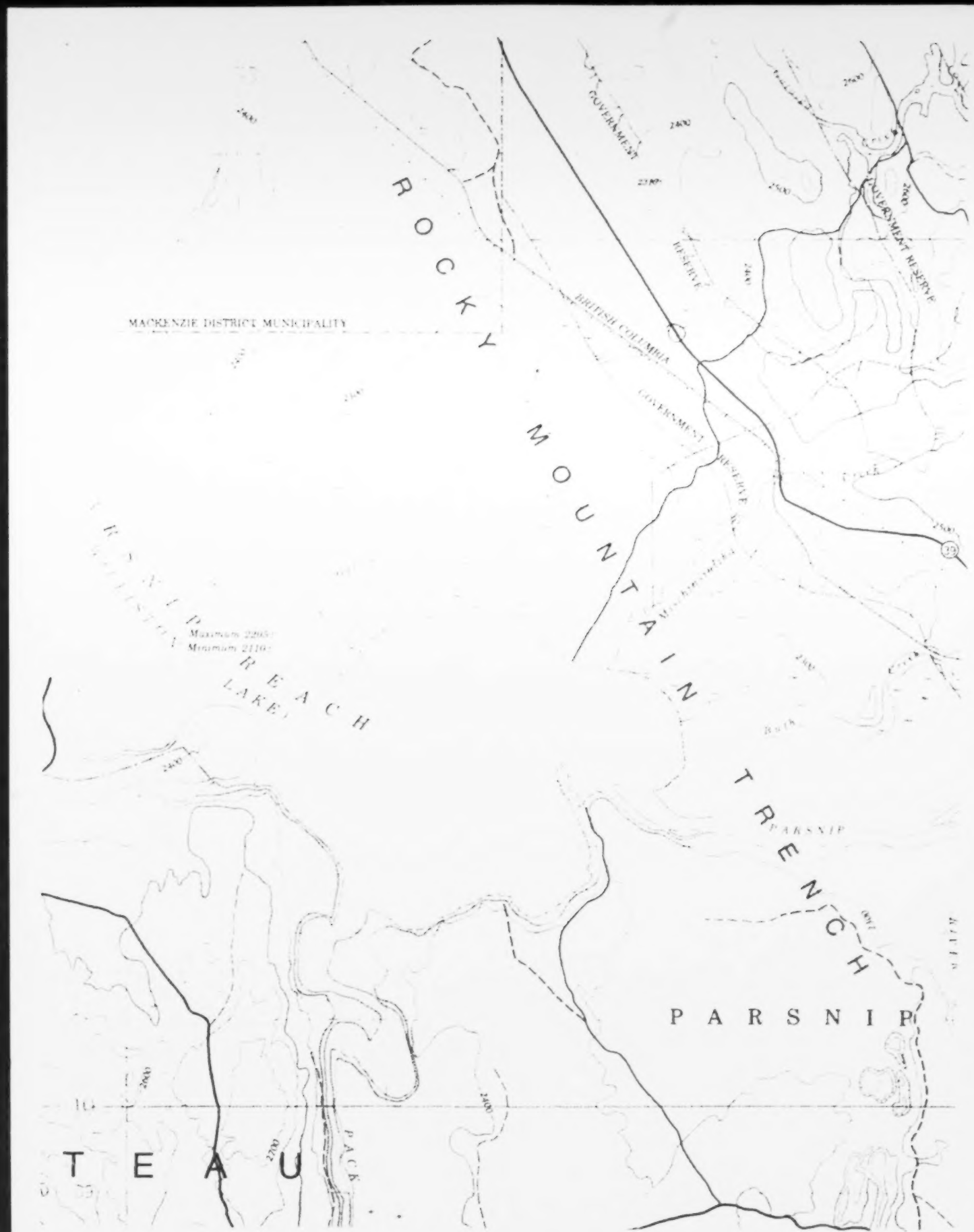


Figure 2. Wetlands monitored in addition to the main Tutu-Mugaha study area.

FINLAY
MACKENZIE DISTRICT MUNICIPALITY
MOUNTAIN
HILL
GOVERNMENT RESERVE
AGENT RESERVE
Maximum 2305'
Minimum 2130'


MACKENZIE DISTRICT MUNICIPALITY
ROCKY
MOUNTAIN
TRENCH
PARSNIP
TEAU
BEACH
LAKE
GOVERNMENT RESERVE
BRITISH COLUMBIA


ROCKY MOUNTAIN TRENCH
MACKENZIE DISTRICT MUNICIPALITY
PARSNIP
TEAU
PARSNIP
PACK
LAKE
BEACH
BRITISH COLUMBIA
GOVERNMENT
RESERVE
GOVERNMENT RESERVE
2400
2200
2600